Sustainable Agriculture in the Mid-Atlantic States

Technical Note 2
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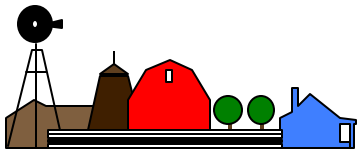

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Natural Resources Conservation Service (NRCS)

Sustainable Agriculture and Pests

Two of the main components of sustainable agriculture are the concept of improving the environmental quality of the farm through utilizing natural resources and biological cycles whenever possible and maintaining farm profitability. At the same time, one of the challenges in farming is how to deal with pests (including weeds, insects and diseases). Pest control ranks as an important conservation treatment in the Mid-Atlantic states[1], accounting for 95 percent of the NRCS East Region's acres reported as having "Pest Management" (conservation practice standard, Code 595A[2]) applied for fiscal year 1999[3].

The science of agriculture has a multitude of methods to control pests, ranging from applications of pesticides to mechanical means. "Pesticides are substances used to control pests. Included are insecticides, herbicides, defoliants, fungicides, nematicides, and rodenticides. Even a common substance like water or salt may be a pesticide if used to control a pest."[4] In the selection of a pest management system and its application, sustainable agriculture techniques take into consideration the effectiveness in protecting the crop and ensuring a harvest, as well as how the system will impact the local environment.

Out of the various types of agricultural pests, "weeds are the biggest pest problem for most field crops and, consequently, more herbicide is used on U.S. farms than insecticide and fungicide."[5] Weeds can be such an issue that chemical herbicides may still be used in limited amounts and responsibly in a sustainable agriculture operation. "Although certified organic farmers do not use herbicides, low-input farmers sometimes do. In fact, weeds are a primary reason why some people remain 'low-input' rather than becoming totally organic."[6]

However, as with all things there are positive aspects as well as negative. Most of us are aware of the negative aspects of weeds, including competition for nutrients and moisture.

Note:
The goal of this series of technical notes for the Mid-Atlantic is to give a brief overview of different sustainable agriculture concepts, and then highlight an innovative farming operation (case study) in the Mid-Atlantic area. The audience targeted is our farming clientele, as well as our own field staff who work with agricultural producers

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But *The Real Dirt*[6] also lists some positive aspects of weeds:

- Deep-rooted weeds can bring up nutrients, and break up hard pans.
- Weeds can act as a green manure or cover crop, also adding organic matter to the soil.
- Weeds can be used as indicators of soil conditions.
- Weeds can provide habitat for beneficial organisms.

Resources:

[1]Mid-Atlantic states = DE, MD, NJ, NY, PA, WV.
[2] Conservation Practice standards can be found at http://www.ftw.nrcs.usda.gov/nhcp-2.html.
[3]"Performance and Results Measurement System," USDA Natural Resources Conservation Service (NRCS), FY99.
[4] Small Farm Handbook, Small Farm Center, Univ. of California, Division of Agriculture and Natural Resources, Publication SFP001, 1994, p. 79.
[5] Cover letter to the report "Pest Management in U.S. Agriculture", USDA Economic Research Service, Jorge Fernandez-Cornejo and Sharon Jans, Agric. Handbook No. 717, August 1999.
[6]"The Real Dirt, Farmers Tell About Organic and Low-Input Practices in the Northeast", Northeast Organic Farming Association, 1994, p. 63.

Weed Seed Banks

Summarized from "Weed Seed Bank Dynamics: Implications to Weed Management" by D. Buhler, R. Hartzler, F. Forcella, Journal of Crop Production, Vol 1, No. 1, 1998, p. 145-168.

Weed science formerly focused on control technology instead of understanding "weedy species and their interaction with the agroecosystem." A weed seed bank is the amount of weed seeds stored in the soil. Most annual weed populations regenerate from this "seed bank."

Understanding the interaction of weeds and crops helps with weed control decisions:

- Crop competition by itself decreases weed seed production. (Example: Cocklebur without competition produced 7000 seeds/plant, but grown with soybeans produced only 1100 seeds/plant.

- Increased shading reduces seed production. This happens when the crop emerges before the weeds.

- Seed predation (by insects, birds and small mammals) is typically less in agricultural systems with intensive soil disturbance, seed burial by tillage, and lack of habitat for predators. Research has shown that in a no-till soybean system 69 percent of the weed seed was lost due to predation, compared with 27 percent in a conventional tillage system.

Management practices can impact the weed seed bank:

1. *Crop rotation.* It's an effective method of control because selection pressure is diversified by changing patterns of disturbance. Research showed that "growing corn in a soybean/corn or soybean/wheat/corn rotation greatly reduced giant foxtail seed in the soil compared to corn grown continuously, regardless of the herbicide use or tillage system."

2. *Tillage systems*. The effect of tillage practices on summer annual weed species involves many factors, but "…seed depth in the soil may be the most important factor."

Moldboard plowing results in the most uniform distribution of seed over soil depths. A no-till system has more than 60 percent of weed seed in the upper 1 cm of the soil. A chisel plow system has 30 percent of weed seeds in the upper 1 cm and "seed concentration decreased linearly with depth. A reduced tillage system had 85 percent of weed seeds in the upper 5 cm of soil.

Exposure to light breaks seed dormancy in some species. Therefore, timing of tillage has been found to impact weed seed germination. Research from 1969 through 1994 has found that tillage during daylight increased weed populations, while tillage during darkness reduced weed populations.

3. *Planting time.* Adjusting the planting date of a crop can impact weed seed germination. "Delaying soybean planting reduced weed populations and improved weed control with rotary hoeing and cultivation." Pigweed species were reduced by 25 percent and common lambsquarters by 80 percent.

Natural Resource Concerns

With weed management, there may be natural resource issues that need attention:

1. Soil Loss problems from too much tillage used for weed control, to inappropriate crop selection (insufficient cover and soil stabilization by roots and plant residue for the site conditions of slope steepness and soil type).

2. Water Quality issues that are dependent on soil types. A sandy, porous soil that has a high water table is more likely to have the ground water quality compromised from improper chemical application.

3. Natural Biological Cycles disturbed through management decisions. Monocropping and applying the same pesticides year after year may allow for a build up of resistance by the pests targeted, thereby making the management practice less effective, while potentially decreasing the local environmental quality.

As one can see, pest management, just one part of the farming equation, can be a complicated matter, especially if one wants to protect the environment and use natural cycles whenever possible. We can't even scratch the surface of this topic in this publication. There are many excellent resources on the topic, some of them already quoted in this technical note. However, the case study on page 4 is a "real life" example of how a farmer is addressing these issues in his operation.

Pesticides in Streams and Ground Water of the US, 1993-1995

1. Seventy-five pesticides were detected at least once in 4,800 water samples collected from 20 of the largest and most important river basins and aquifers in the United States during 1993-95.

2. Pesticides were detected more frequently and at higher concentrations in streams than in ground water. About 95 percent of all samples collected from streams contained at least one compound, compared to about 50 percent of ground-water samples.

3. Herbicides most frequently found in streams and ground water: atrazine and metolachlor (used on corn and soybeans), prometon (used in urban settings), and simazine (used in agricultural and urban settings).

Summarized from a report by Robert Gilliom of the U.S. Geological Survey, in "The State of North America's Private Land" abstracts report from Jan. 19-21, 1999 published by the Soil and Water Conservation Society.

CASE STUDY:

The Groff Family: Lauren, Steve, David, Cheri, and Dana (from left to right)

Cedar Meadow Farm

Owners: Steve and Cheri Groff
Location: Holtwood, Lancaster County, Pennsylvania
Farmed Acres: 175 acres of crops and vegetables

Enterprises:
Corn, alfalfa, vegetables, soybeans, small grains, and the following educational videos: "No-Till Vegetables: A Sustainable Way to Increase Profits, Save Soil, and Reduce Pesticides," "Cedar Meadow Farm, A Model for Clean Water and Healthy Soil."

Resource Issues:
Soil quality
Pest management
Profitability while still protecting the natural resources

Socioeconomic Goals:
Income stability
Diversity

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Site Description:
Located in southeastern Pennsylvania, Lancaster County's natural resources contribute to its fame of prime farmland. Having an average summer temperature of 72°F, an average winter temperature of 32°F, with a total annual precipitation of 43 inches creates ideal conditions for many agricultural crops. The growing season is from April to September, with 56 percent of the rain falling in this time period. The sun shines 65 percent of the time possible in the summer, and 50 percent in the winter. During the winter, Lancaster County has an average seasonal snowfall of 27 inches.

By taking a drive through "Amish Country," as it is known in the tourist trade, with its picturesque farms, one begins to see that the average farm size in the county is about 82 acres. Cedar Meadow Farm is part of the 80 percent acreage suitable for cultivation out of over 600,000 acres in the county. The Groff's farm sits in Martic Township, which borders on the Susquehanna River.

The soils on the farm are mainly Manor and Glenelg. In general, these soils are nearly level to very steep, well drained soils on broad ridgetops and side slopes; formed in residuum from mica schist, granitized schist, quartzite, and gneiss. Manor and Glenelg both have medium textured subsoils. One third of the farm is considered prime farmland with the soil GbB (Glenelg silt loam, 3-8 percent slopes). The other two thirds of the farm are on steeper slopes with shaley hillsides. This combination makes it different from the rich, relatively flat limestone soils in other parts of the county.

Introduction to Cedar Meadow Farm:
Steve, his wife Cheri, their three children, and his father Elias continue the family tradition of farming with an awareness of protecting the natural resources of the area. Steve's grandfather started this tradition when he purchased the farm in 1935. Steve's father, Elias Groff, was raised on this farm, then bought an adjacent farm to raise his family and pass on the family knowledge and enthusiasm with farming. In 1988 Steve moved to his grandfather's farm to continue the legacy on Cedar Meadow Farm.

Steve is dedicated to proving, through research collaboration with University and NRCS scientists, that conservation practices provide benefits and are worth the effort. He also works diligently at sharing his knowledge with other farmers through annual field days, an active World Wide Web site (http://www.cedarmeadowfarm.com), production of educational videos, and with speaking engagements around the world.

Concerning sustainable agriculture, Steve believes "that any system has to be profitable for the farmer, in order to be sustainable for the long term. Environmental responsibility should be carried out to the best of the producer's ability in relation to the knowledge and experience he or she has. I don't think there are shortcuts to sustainability without the collaboration of researchers, networking with other farmers, and thoroughly studying the feasibility of an unfamiliar practice."

Satisfying Food/Fiber Needs:
Cedar Meadow Farm is a crop and vegetable operation. Products include corn, soybeans, hay, and annual vegetables including tomatoes, pumpkins, sweet corn, broccoli and peppers. His father, Elias, also raises about 70 steers each year.

Enhancing Environmental Quality & Making Most Efficient Use of Resources and Natural Cycles:

Soil quality is a main goal on Cedar Meadow Farm.

Steve says, "Erosion takes away your very best soil! It's your surface soil that has the highest fertility that goes 'down the drain,' during a rainstorm. If you farm land that is susceptible to erosion, controlling it should be your top priority. Soil erosion is the most detrimental aspect of agriculture. We can't turn our backs on soil erosion and call ourselves sustainable!"

To reach this goal, Steve pioneered what is called "Permanent Cover Cropping Systems." These systems use no-till, cover crops and crop rotations to increase profits, enhance soil and water quality, and reduce pesticides, in addition to reducing soil erosion.

Steve began using cover crops in 1991. Some of the fields have not been tilled in over 30 years, and each year he diversifies the crop rotation to fit the current needs of the operation.

He elaborates, "I started no tilling in the early 80's on about 15 corn acres because we had some erosion problems, and I didn't like having to fill in gullies before harvesting corn, and I felt that wasn't right. In 1991 I began using a rye cover crop as another soil-conservation method. In 1994 we started no-tilling tomatoes and in three years, all of our 175 acres of 15 different crops were no-tilled. This 'Permanent Cover Cropping System' is done successfully by using cover crops, intensive crop rotation, and long-term no-tillage. I can't emphasize enough how these three components are the foundation to make this system work. No-till is not the 'magic bullet.' It is an equal partner with cover crops and rotation. I use this system for three reasons: increase profits, enhance soil quality, and reduce pesticides."

Using these systems, Steve has achieved his goal of reducing erosion, from 14 tons/acre/year of soil loss down to less than 1 ton on slopes of 3-17 percent. Other benefits achieved include better weed control, which leads to reduced pesticide use and improvement of the quality of the soil and water of the farm. (Further details of research data can be found on his Web site.)

Steve suggests, "The first key to success is to have a learning attitude! Then get experience and the proper equipment. Don't adopt my system, but adapt it to your unique situation. The fundamental principles of this system are applicable to most anywhere in the world."

Sustaining Economic Viability:

Concerning economics, Steve says, "It's hard to put a dollar value on the other benefits cover crops give such as erosion control, better soil quality, and increased organic matter, but it has to be factored in at least indirectly. On my farm I've been able to grow my own cover crop seed and use a rolling stalk chopper to control the covers. This allows me to further reduce expenses. Our yields have increased the last several years and this adds to the profit."

Table 1 below shows Net Returns from various crops after paying variable costs. Variable Costs include preharvest expenses (seed, fertilizer, chemicals, and irrigation) and harvest expenses. Labor costs and variable equipment costs for such items as repairs, fuel and oil are included. Basically all the costs that vary with the level of production are included in Variable Costs. Variable Costs do not include the Fixed Costs associated with equipment, nor do they include any payment to management or for use of the land.

As shown in the table, returns from pumpkins, fresh pack tomatoes, and rye/vetch far surpass those associated with corn and soybeans. Particularly interesting is Cedar Meadow Farm's (CMF) success in tapping into the highly profitable rye/vetch niche market. Return on that investment was spectacular and it was achieved with a minimum amount of risk.

Table 1, Net Returns after Variable Costs for Different Crops--1999
(All crops are No-Till; all crops are irrigated except rye/vetch and soybeans)

	Yield	Selling Price	Gross Receipts/Ac	Variable Costs/Ac*	Net Returns/Ac*
Corn for Grain	100 bu**	$2.50/bu	$250	$185	$65
Soybeans	40 bu	$6.00/bu	$240	$101	$139
Pumpkins	10 tons	$230/ton	$2,300	$584	$1,716
Tomatoes (Fresh Pack)	600 cwt	$32/cwt	$19,200	$10,579	$8,621
Rye/Vetch	36 bu	$44.54/bu	$1,603	$42	$1,557

*Variable costs include all the costs which vary with the level of production such as seed, fertilizer, chemicals, gas/diesel/repairs, labor. Net Returns must be sufficient to compensate the manager and to generate a return for using the land as well as covering the Fixed Costs associated with equipment ownership. Thus, Net Returns must ultimately cover not only Variable Costs but Fixed Costs as well.
**Not representative, reflects the effects of drought.

Networking with neighbors provided the entree for movement into pumpkin and tomato enterprises--CMF piggybacked onto their existing operations. Care must be exercised in ensuring a market for the produce though. In one prior year, fifty tons of pumpkin were left in the field for lack of market.

The effects of the 1999 drought were mitigated by irrigation and the use of cover crops in conjunction with no-till. CMF has also increased profitability by producing their own pumpkin and vetch seed. They

use custom operators for tomato and soybean harvesting. This helps reduce equipment Fixed Costs as shown in Table 2 below.

Table 2, Equipment Fixed Costs Per Acre

	Corn for Grain	Soybeans	Pumpkins	Tomatoes (Fresh Pack)	Rye/Vetch
Net Returns after Variable Costs	$65	$139	$1,716	$8,621	$1,557
Equipment Fixed Costs	$51	$20	$23	$8	$41
Net Returns after Variable Costs and Equipment Fixed Costs*	$14	$119	$1,693	$8,613	$1,516

*Funds available to compensate management and to pay for land costs.

Table 3 shows how profitability would have been affected for the different crops based on different prices.

Table 3, Net Returns after Variable Costs and Fixed Equipment Costs Per Acre at Different Price Levels Using 1999 Yields

(Information as contained in Tables 1 and 2 except for changed selling prices)

Prices Relative to 1999 Levels	Corn for Grain	Soybeans	Pumpkins	Tomatoes (Fresh Pack)	Rye/Vetch
+20%	$64	$167	$2,153	$12,453	$1,836
1999 Prices	$14	$119	$1,693	$8,613	$1,516
-20%	-$36	$71	$1,233	$4,773	$1,196

Quality of Life:

Despite Steve's tremendous efforts at implementing innovative farming techniques and sharing this knowledge, he still finds time to play and be with his family. He enjoys hunting, attending church, surfing the Internet, as well as interacting with other farmers.

He and his wife also make an effort to raise their three children with a balance of fun activities, such as watching hot air balloons and visiting friends, with teaching responsibility as they share the family tradition of farming in a way that not only supports the family, but also supports and protects the natural resources.